REMARKS

Claim 1, 3-8, 15-16, 19-20, 36-37, and 52-63 are currently pending. Applicants have withdrawn claims 38-51 and 64 as being directed to non-elected invention. Claim 1 has been amended to recite "chemically defined constituents." This amendment is supported in the specification at least at page 5, lines 3-7, and does not contain new matter. Applicants address the Examiner's rejections in view of the amended claims.

Rejection under 35 U.S.C. 112

Claims 1, 3-8, 15-16, 19-20, 36-37 and 52-63 were rejected as allegedly being indefinite under 35 U.S.C. § 112, second paragraph. In particular, claims 1 and 52 were rejected for reciting the phrase "contains only chemically defined components." As previously indicated, claim 1 has been amended to recite "chemically defined constituents" which is clear and definite. For example, the specification teaches that "chemically defined constituents includes [sic] a medium which does not contain a complex carbon and/or nitrogen source, i.e. which does [n]ot contain complex raw materials having a chemically undefined composition." (Specification at page 5, lines 2-7). The term "chemically defined" in reference to culture medium is also well-known to those skilled in the art. As described on page 2 of the "Traders' Guide to Fermentation Media Formulation" (attached as Exhibit 1),

> "Often a culture medium is prepared using pure compounds in precisely defined proportions. Media of this type are called synthetic or defined and examples are shown in Table 1. Alternatively, media can be formulated using ingredients of natural origin which are not completely defined chemically such as blood, meat extracts, molasses and cotton seed flour. These are referred to as complex or natural media… ."

Furthermore, claims 3, 7, 52 and 56 were rejected under 35 U.S.C. § 112 as allegedly vague and indefinite because of the term "and/or." Applicants have amended these claims to recite "and." Accordingly, the amended claims are clear and definite, and Applicants respectfully request that this rejection be withdrawn.

Rejections under 35 U.S.C. § 103

Claims 1, 3-8, 15-16, 19-20, 36-37 and 52-63 were rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable under Hogye *et al.* (Derwent 1987-357537 abstract), in view of Bovenberg *et al.* (U.S. Patent 5,731,163) and Pelczar *et al.*, *Microbiology* 4th Edition, pages 853-856. Applicants must respectfully disagree and address the Examiner's rejection in view of the amended claims.

First, there is no motivation to combine Hogye *et al.*, Bovenberg *et al.*, and the *Microbiology* reference. The *Microbiology* reference explicitly teaches an industrial process using complex raw materials. In contrast, Bovenberg *et al.* describe only small scale production of phenylacetyl-7-ADCA, also using complex raw materials. As described in Example 1, 20 mL of the seed culture is incubated, and 1 mL was used to inoculate 15 mL of production medium. Similarly, there is no indication in Hogye *et al.* that industrial scale production is described or contemplated. On the contrary, the description that "[a] nitrogen level of 20 mg/100 ml. min. is maintained" (*emphasis added*) suggests that the fermentation process is on a small scale. As indicated in the specification, large-scale industrial fermentation processes typically have a volume scale of about $10m^3$ or larger, whereas small fermentative scales typically do not exceed a volume of about 20-40 L. (See Specification at page 3, lines 11-24). Where the references teach away from their combination, it is improper to combine the references. MPEP § 2145 [quoting *In re Grasselli*, 713 F.2d 731, 743 (Fed. Cir. 1983)].

Second, even if combined, the combination does not teach all the elements of the presently claimed invention. As previously indicated, Bovenberg *et al.* and the *Microbiology* reference teach a process using fermentation medium containing complex media. Example 1 of Bovenberg *et al.*, teaches that adipoyl-7-ADCA producing transformants were inoculated into a seed medium consisting of glucose, cotton seed meal, corn steep solids, and other components. The *Microbiology* reference also teaches the manufacture of penicillin using a medium of corn steep liquor, lactose, salts and other ingredients (See, page 856). Similarly, contrary to the Examiner's assumption that Hoyge *et al.* teach a fermentation media of chemically defined components, the

fermentation medium in Hoyge *et al.* comprises corn steep liquor. Enclosed for the Examiner's attention is an English translation of the Hoygé *et al.* patent, attached as Exhibit 2.

Unlike chemically defined components, cotton seed meal, corn steep solids and corn steep liquor are complex raw materials obtained using natural sources. (See, specification at page 1, lines 21-24). Specifically, corn steep liquor and solid are co-products of corn wet-milling processes, starting from cleaning and steeping corn in hot water. The steep water containing dissolved organic and inorganic matter extracted from corn is then concentrated, resulting in corn fermented extractives or corn steep liquor, a semi-solid mass containing about 50-55 % solids. (See, Davis, "Corn Milling, Processing and Generation of Co-Products," Minnesota Nutrition Conference, attached as Exhibit 3). Thus, the combination of Hoyge *et al.* with Bovenberg *et al.* and the *Microbiology* reference would teach a fermentation process using a complex media such as corn steep liquor.

Furthermore, even if combined, the combination fails to teach a process for the production of a β-lactam, on a volume scale of at least 10 m^3. The Examiner concedes that "Hoyge does not teach the process of the production of Beta-Lactum [sic] and its recovery, . . . wherein the fermentation process produce[sic] Beta-Lactum [sic] at volume scale at least 10m3." (Office Action, page 4). As previously indicated, Bovenberg *et al.* teaches only a small scale production of phenylacetyl-7-ADCA. While the *Microbiology* reference teaches an industrial process, the process only involves use of complex raw materials.

Finally, there is no reasonable expectation of success that the combination will result in industrial scale production of β–lactam using a fermentation medium containing only chemically defined constituents as carbon and nitrogen sources. As indicated in the specification, the product yields which would be obtained using chemically defined media on an industrial scale were typically considered to be substantially lower than those obtained using media containing complex raw materials. In addition, high-producing microbial strains which have been developed for industrial processes in complex media were suspected not to retain their good performance in chemically defined media. (See, Specification at page 2, line 34 through page 3, line 7).

Based on the above, the claims are nonobvious. Thus, Applicants respectfully request that the rejections under 35 U.S.C. § 103 be withdrawn, and the claims be passed to allowance.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue. If it is determined that a telephone conference would expedite the prosecution of this application, the Examiner is invited to telephone the undersigned at the number given below.

In the event the U.S. Patent and Trademark office determines that an extension and/or other relief is required, applicant petitions for any required relief including extensions of time and authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to Deposit Account No. 03-1952 referencing docket no. 246152012710. However, the Commissioner is not authorized to charge the cost of the issue fee to the Deposit Account.

Dated: March 29, 2004

Respectfully submitted,

By Emily Tongco

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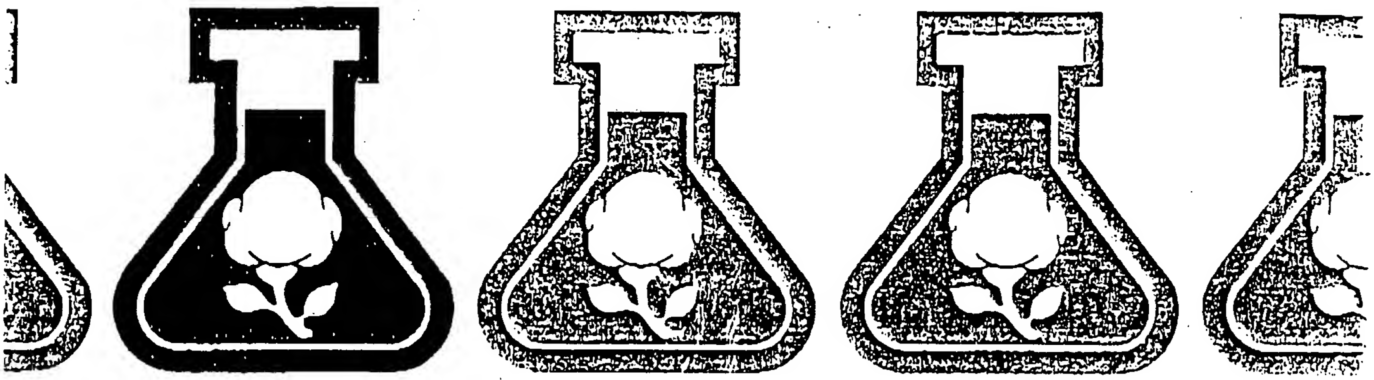
2810.



TRADERS' GUIDE TO FERMENTATION MEDIA FORMULATION

D. W. Zabriskie, PhD, BioChem Technology, Inc.
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Traders Protein gratefully acknowledges the assistance of BioChem Technology, Inc., Malvern, Pennsylvania USA in the preparation of this book. We also appreciate the assistance of Dr. W. W. Umbreit, Rutgers University, and Dr. B. W. Churchill, The Upjohn Company.

compounds usually closely relate^d to the form in which they will ultimately be inc orated in the cellular material.

energy source in water.
Final pH 7.4 to 7.6. Fc d medium (pH 5 - 5.5) add 6 ml of 1 N H_2SO_4 per liter of final medium.

1

(c) Cerelose -- Corn Products, a unit of ...

The microbial environment is largely determined by the composition of the growth medium. Media are generally formulated for specific purposes. A cultivation medium is designed to support active growth whereas a storage medium is used for its ability to sustain viability under conditions unfavorable for growth. An enrichment medium is used to enhance the growth of a particular species in the presence of other contaminants. Differential media are used in the identification process, and media for determination of physiological properties are generally used to study microbial metabolism (2).

Often a culture medium is prepared using pure compounds in precisely defined proportions. Media of this type are called synthetic or defined, and examples are shown in Table 1. Alternatively, media can be formulated using ingredients of natural origin which are not completely defined chemically, such as blood, meat extracts, molasses, and cottonseed flour. These are referred to as complex or natural media and some examples are shown in Table. 2.

Defined media are usually preferred for research since they permit one to determine the specific requirements for growth and product formation by systematically adding or eliminating chemical species from the formulation. Other advantages of a defined medium include its reproducibility, low foaming

1. Fermentation Media Formulation

1.1. Introduction

It is generally accepted that fermentation media development is a mixture of art and science. The scientific basis rests with those fundamental biochemical aspects of microorganisms which are general to large groups of species. The art is required when the specific biochemical details of the species of interest are unknown. Success or failure then rests on the microbiologist's experience and judgement to experimentally determine the environmental conditions which best allow the microorganism to express the biological characteristics of commercial importance.

Two nutritional factors essential to microbial activity are 1) a source of energy for cell metabolic processes, and 2) a source of materials from which cellular matter and products can be synthesized. Microorganisms can obtain energy from their environment in a variety of ways. Some algae, photosynthetic bacteria, and protozoa utilize solar radiation for this purpose and are termed phototrophs. Most microorganisms, however, use the energy stored in the chemical bonds of various compounds and are called chemotrophs. Chemotrophs can be subdivided into lithotrophs and organotrophs depending on their ability to utilize inorganic and organic material as an energy source. The means by which carbon is assimilated provides another basis for classifying microorganisms. Autotrophs only require carbon as CO_2 while heterotrophs require carbon in more complicated molecular forms (1). The microorganisms of greatest commercial importance are the heterotrophs (1).

The second nutritional factor is the requirement for sources of all the elements (C, H, O, N, P, S, K, etc.) that will be combined in various ways to form cellular material or products. Some microorganisms can utilize elements in the form of simple compounds while more fastidious species require their nutrients as more complex compounds usually closely related to the form in which they will ultimately be incorporated in the cellular material.

Table 1
Defined Media Used in Laboratory Studies

Davis Medium (3)

Suitable for enteric fermentative microorganisms

Energy Source	2 g/l
K_2HPO_4	7 g/l
KH_2PO_4	3 g/l
$MgSO_4 \cdot 7H_2O$	0.5 g/l
Na-Citrate • $3H_2O$	0.5 g/l
$(NH_4)_2SO_4$	1 g/l

"B" Medium (4)

Low in phosphates-suitable for oxidative microorganisms

Energy Source	1-10 g/l
K_2HPO_4	1 g/l
$MgSO_4 \cdot 7H_2O$	0.3 g/l
$(NH_4)_2SO_4$	1 g/l
NaCl	0.2 g/l
Iron	Trace
Trace Elements Concentrate	1-10 ml/l

Trace Elements Concentrate

EDTA	5 g/l
$ZnSO_4 \cdot 7H_2O$	0.22 g/l
$CaCl_2$	0.55 g/l
$MnCl_2$	0.5 g/l
$FeSO_4$	0.5 g/l
$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$	0.1 g/l
$CuSO_4$	0.16 g/l
$CoCl_2$	0.16 g/l

Vogel and Bonner Medium (5)

Nutrient Concentrate-self sterilizing. Dissolve the components below in 670 ml of water in order listed:

$MgSO_4 \cdot 7H_2O$	10g
Citric Acid • H_2O	100g
K_2HPO_4 • anhydrous	500g
$Na(NH_4)HPO_4 \cdot 4H_2O$	175g

Final medium made by aseptically adding 1 ml of concentrate to 49 ml of a sterilized solution of the energy source in water.

Final pH 7.4 to 7.6. For acid medium (pH 5 - 5.5) add 6 ml of 1N H_2SO_4 per liter of final medium.

tendency, translucency, and the relative ease of product recovery and purification. However, in many cases low product yield and poor economy make complex or natural media the preferred choice in industrial fermentations (9).

The process of fermentation media formulation usually begins by developing a carefully defined formulation to determine the specific requirements. This phase is followed by a transition to a natural media in order to scale-up the formulation to a commercially viable process. In the discussion to follow, it is assumed that the growth and product formation requirements have been determined in the laboratory on a defined medium, and it is now desired to formulate a media based upon natural ingredients.

1.2. Components of Industrial Fermentation Media

Fermentation nutrients can be classified as sources of carbon, nitrogen, inorganic components, and vitamins according to their principal function in the medium. Carbohydrates are referred to as carbon sources, although they also supply combined oxygen and hydrogen. Proteins and amino acids are important nitrogen sources, although they also are sources of carbon, oxygen, hydrogen, and sulfur. The objective in formulating the medium is to blend ingredients rich in some nutrients and deficient in others with materials possessing other composition profiles to achieve the proper balance.

1.2.1. Carbon Sources

1.2.1.1. Carbohydrates

Carbohydrates are excellent sources of carbon, oxygen, hydrogen, and metabolic energy for many microorganisms. They are available as simple sugars or as sugar polymers such as starch, dextrins, cellulose, and hemicellulose. Since biomass is typically 50% carbon on a dry weight basis, carbohydrates frequently are present in the media in concentrations higher than other nutrients and are used in the range of 0.2-20%

Although all carbohydrates have an empirical formula of $(CH_2O)_n$, they are not equally available to microorganisms. In general terms availability may be ranked as hexoses $>$ disaccharides $>$ pentoses $>$ polysaccharides. The yeast *Saccharomyces cervisiae* can only grow on some hexoses and disaccharides while the yeast *Candida utilis* will grow on some hexoses, disaccharides, and pentoses. Neither strain will grow on polysaccharides such as starch, hemicellulose, and cellulose. These materials can be made available to the yeast only after the polymers are hydrolyzed to yield simple sugars using acid, base, or enzymatic catalysts. Other microorganisms such as *Bacillus subtillus* and *Trichoderma reesei* secrete extracellular hydrolytic enzymes into their environment. These enzymes are capable of depolymerizing polysaccharides to form simple sugars. Still other microorganisms can grow well on a variety of carbohydrates, yet the yield of product may be strongly dependent on the source. Table 3 demonstrates this situation for the production of a β-lactam antibiotic by *Cephalosporium acremonium* in which glucose favors cell growth, galactose maximizes antibiotic concentration, and sucrose optimizes antibiotic yield per cell(10). It is therefore important to determine these nutritional characteristics before selecting a carbohydrate source for the cultivation of a specific species.

Simple sugars are available as powders or syrups, provided in a variety of purities. Glucose and sucrose are used in the greatest volumes by the fermentation industry. Glucose is generally derived from the hydrolysis of corn starch, although starch from other grains and cellulosic materials is sometimes used. Sucrose is most often purchased as molasses. Lactose from cheese whey and xylose from sulfite waste liquor are used in smaller amounts.

Table 3

β-Lactam Antibiotic Production by *Cephalosporium acremonium* on Different Carbohydrates (10)

Carbon-Source	Antibiotic Concentration μg/ml	Cell Concentration mg/ml	Yield of Antibiotic μg/mg of Cells
Glucose	830	22.5	36.9
Maltose	1130	21.8	51.9
Fructose	1250	21.5	58.1
Galactose	1650	19.1	86.4
Sucrose	1040	11.9	87.4

S.B.G.&K. PATENT AND LAW OFFICES
PARTNERSHIP OF LAWYERS AND PATENT ATTORNEYS BUDAPEST

Budapest, May 15, 2003

Your ref.: 02818US/DIV1/VS

Our ref.: GEN/82/03/SZE/Szö

VIA TELEFAX
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Total pages: 4

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VS				
	TO	CO	TAX	CIRC

Messrs.
DSM N.V.
Patents and Trademarks
Attn.: Dr. V.R. Swarte
Delft

Re.: US Patent Application No. 09/982,474 (Hungarian Patent No. 195540) in the name of DSM N.V.

Dear Sirs,

This is to revert to your fax message of 13, May 2003.

Please find below the components of the fermentation media as mentioned in the examples:

Example 1:

Peanut flour
Corn steep liquor (100% dry material content)
Sodium thiosulphate
calcium carbonate
sunflower oil

Example 2:

Peanut flour
Corn steep liquor (100% dry material content)
Sodium thiosulphate
calcium carbonate
phenoxyacetic acid

1062 BUDAPEST, ANDRÁSSY ÚT 113.
TELEPHONE: (+36-1) 461-1000, TELEFAX: (+36-1) 461-1099, POSTAL ADDRESS: 1369 BUDAPEST, P.O.Box 360 HUNGARY
E-MAIL: mailbox@sbgk.hu INTERNET: http://www.sbgk.hu

Example 3:

Peanut flour
Corn steep liquor (100% dry material content)
Sodium thiosulphate
calcium carbonate
sunflower oil

Example 4:

Peanut floor
Corn steep liquor (100% dry material content)
Sodium thiosulphate
calcium carbonate
sunflower oil
phenoxyacetic acid

Example 5:

Peanut floor
Corn steep liquor (100% dry material content)
Sodium thiosulphate
calcium carbonate
sunflower oil
phenoxyacetic acid

The last paragraphs of each example show the amounts of ingredients used for biosynthetising 1 kg penicillin. The list of these materials in all examples are as follows:

sacharose
ammonium sulphate
phenoxyacetic acid
corn steep liquor (100 %)
Peanut flour

B S&K G

Please be advised that Example 1, most probably by mistake, lists phenylacetic acid instead of the phenoxyacetic.

Should you wish to obtain additional information, please do not hesitate to contact us.

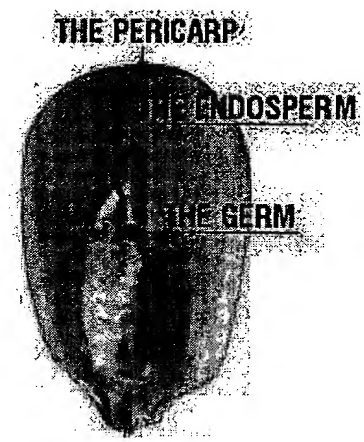
Very truly yours,

Ádám Szentpéteri, Jr.
Managing Partner

Minnesota Nutrition Conference
Minnesota Corn Growers Association
Technical Symposium
September 11, 2001

Corn Milling, Processing and Generation of Co-products

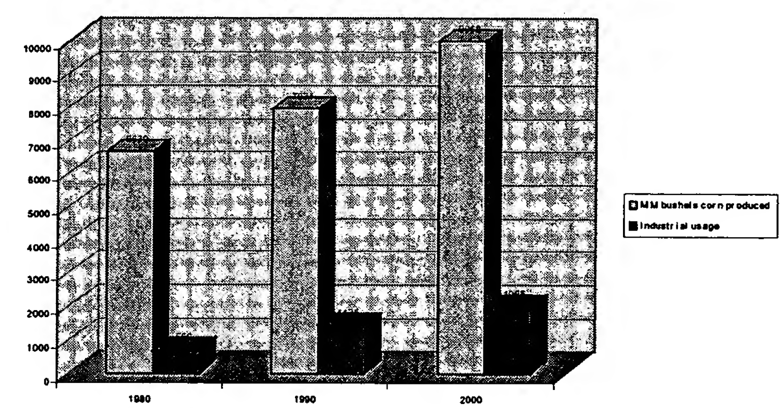
Corn, a distinctive American crop, developed by the Indians, roasted at 4th of July picnics and produced with unparalleled efficiency and dedication by farmers. For every five bushels sold, corn processors buy one bushel to process in to corn syrups, sweeteners, starches, oils, ethanol and animal feeds. These products in turn become the building blocks of thousands of other food and industrial products distributed throughout the world. Eighty percent of all corn grown in the US is fed to livestock, poultry and fish. Nutritional components of yellow dent corn are well known.



Components of Yellow Dent Corn

Starch	61.0 %
Corn Oil	3.8 %
Protein	8.0 %
Fiber	11.2 %
Moisture	16.0 %

Currently in an average year the remaining twenty percent or about two billion bushels of shelled field corn is transported from individual farms by truck, train and barge to industrial corn processing plants. This percentage of "industrial use" versus the amount of corn produced has increased over the decades from 9.9% in 1980 to 17.9% in 1990 to the current 19.7%.



With the new bio-based product initiatives and our need for renewable energy, researchers are looking at corn as a feedstock for other organic chemicals, nutraceuticals and biodegradable polymers and fibers. This will continue the trend of increasing

Presented by
Kelly S. Davis
Quality Manager
Chippewa Valley Ethanol Company

percentage of corn grown for industrial processes. Educating nutritionists about the feeding values of these valuable co-products and getting the improved quality data into the new feed formulation programs and literatures is becoming of increased importance.

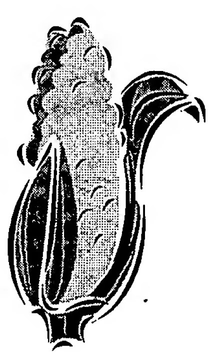
There are two distinct processes for processing corn, wet-milling and dry-milling and each process generates unique co-products.

The Corn Wet-Milling Process

Wet-milling processing roots are designed based in production of pure starch. Corn wet milling has developed into an industry that seeks optimum use and maximum value from each constituent of the corn kernel. In addition to starch and the other various products, as well as the edible corn oil, the industry has become an important source of well- defined specialized ingredients used in feed formulations. The contents of the different component streams segregated during starch and oil production are recombined and processed to yield products serving specific needs of the feed industry.

Production of feed co-products from corn wet-milling begins with the delivery of shelled corn to the facility. The corn is sampled and quality approved. The corn is off loaded to elevator bins through a cleaning system. From the elevator, the corn is conveyed to large tanks called steep tanks where it is soaked for 30-50 hours at 120 - 130°F in a dilute sulfur dioxide solution. This is a closely controlled process that results in the softening of the corn kernels. During the soaking, soluble nutrients are absorbed in to the water. This water is later evaporated to concentrate these nutrients to become *Condensed Corn Fermented Extractives*. Continuing with the milling process the corn germ is removed from the water soaked kernel. The germ is further processed to recover the oil. The remaining portion of the germ, *Corn Germ Meal* (wet or dried), is collected for feed use. After the germ has been removed, the rest of the corn kernel is screened to remove the bran leaving the starch and gluten protein to pass though the screens. The bran is combined with other co-product streams to produce *Corn Gluten Feed*. This starch and gluten slurry is sent to centrifugal separators, which causes the lighter gluten protein to float to the top and the heavier starch to the bottom. The gluten protein is concentrated and dried to form *Corn Gluten Meal,* a 60% protein feed. Some of the starch is then washed and dried, or modified and dried and marketed to the food, paper and textile industries. The remaining starch can be processed into sweeteners or ethanol.

Wet-milling produces four major co-products for the feed industry from the isolated steep water, bran, germ meal and gluten. Together these co-products represent about 25 – 30% of the corn processed.



Average Yield Per Bushel

Starch	31.5 lbs.
Gluten Feed	12.5 lbs.
Gluten Meal	2.5 lbs.
Corn Oil	1.6 lbs.

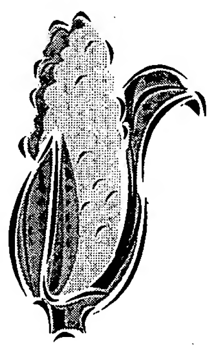
- **Condensed Corn Fermented Extractives** or Corn Steep Liquor is a high-energy liquid feed ingredient. The protein value analyzes at 25% on a 50% solids basis. This product is sometimes combined with the corn gluten feed or may be sold separately as a liquid protein source for beef or dairy rations. It also can be used as a pellet binder and is a source of B-vitamins and minerals.
- **Corn Germ Meal** typically analyzes at 20% protein, 2% fat, and 9.5% fiber. It has an amino acid balance that makes it valuable in poultry and swine rations. It is also used as a carrier of liquid feed nutrients.
- **Corn Gluten Feed** is a medium protein ingredient composed of the bran and fibrous portions. It may or may not contain the condensed corn extractives. This product is also sold as wet or dry. The bran and condensed extractives (sometimes germ meal) are combined and dried in a rotary dryer. The dried corn gluten feed is made into pellets to facilitate handling. It analyzes typically as 21% protein, 2.5% fat, and 8% fiber. Wet corn gluten feed (45% dry matter) is similarly combined but not dried. It is a perishable product in 6 –10 days and must be fed or stored in an anaerobic environment. These feeds are widely used in complete feeds for dairy and beef cattle, poultry, swine and pet foods.
- **Corn Gluten Meal** is a high protein concentrate typically supplied at a 60% protein, 2.5% fat and 1% fiber. It is a valuable source of methionine. Corn gluten meal also has a level of xanthophylls, which offers the poultry feed formulators an efficient yellow pigmenting ingredient. Corn gluten meal also is an excellent cattle feed providing a high level of rumen bypass protein.

The Corn Dry-Milling Process

The beverage ethyl alcohol distilling industry in the late 19th century pioneered the recovery of the nutrients from grains, which had undergone fermentation. It was immediately recognized as an excellent source of dairy cattle feed. Ethyl Alcohol was a critical item during WWII for the manufacturing of munitions. The beverage alcohol industry was asked to meet the demand. Obviously, cereal grains were an important commodity for livestock feed as well as human food and it was necessary to recover these nutrients remaining after the fermentation process. The world oil crisis in the 1970's and recent clean air legislation have contributed to an expanded dry-mill industry. Currently legislative issues are before Congress that could triple the demand for ethanol as an oxygenate component in gasoline. This increased ethanol demand will likely come from the dry-milling of corn thereby offering an increased amount of co-products.

Shelled corn arrives at the facility and is accepted through quality check procedures. The mashing and fermentation of the corn is mechanically simple but from a chemical and biological process are quite complex. The corn is cleaned of foreign materials and hammer milled to a medium-coarse to fine grind meal. This corn meal is then mixed with fresh and recycled waters in known ratios to form a slurry. The pH (5-6 pH) and temperature (180 -195°F) is adjusted and an alpha amylase enzyme is added to facilitate the hydrolysis of the cornstarch to dextrin (long chain sugars). This process step is referred to as liquefaction. After complete liquefaction of the starch the mash is "cooked" to kill unwanted lactic acid producing contaminating bacteria. The mash is

then cooled to 90°F and sent to a fermentation vessel where a glucoamylase enzyme is added that converts the dextrin into the simple sugar dextrose. Yeast species, *Saccharomyces cerevisiae*, are used to metabolically convert the dextrose in to ethanol and carbon dioxide. The fermenting mash is referred to as a "beer". The corn protein and recycled waters (stillage) provide a major source of nitrogen compounds absorbed by the yeast microbes. The fats and fiber in the fermenter remain untouched and concentrate as the starch is converted to ethanol. Fermentation is completed in 40- 60 hours. The beer is then sent to the distillation area to strip away the ethanol. The water and all solids (protein, fat and fiber) are collected from the distillation base and referred to as whole stillage. This whole stillage is then centrifuged to separate the coarse solids from the liquid. The liquid is referred to as thin stillage, which is recycled to the beginning of the process or concentrated in the evaporator to become *Corn Condensed Distillers Solubles.* The coarse solids collected from the centrifuge are called wetcake. Wetcake and condensed solubles are then combined and dried in a rotary dryer to form the feed co-product *Corn Distillers Dried Grains with Solubles.*



Average Yield Per Bushel

Ethanol	2.7 gallons
DDGS	18 lbs.
CO_2	18 lbs.

- **Corn Condensed Distillers Solubles** (CDS) is a term generally used to refer to the evaporated co-products of the grain fermentation industry. Most of the CDS is added to the dried grains but some is available as a liquid feed ingredient. The quality and composition of CDS can be affected by a number of factors including the original substrate, the process used, and evaporation procedures. Nutritional properties of this product can vary greatly. On a dry matter basis CDS typically is 29% protein, 9% fat and 4% fiber. The solubles are an excellent source of vitamins and minerals, including phosphorous and potassium. CDS can be dried to 5% moisture and marketed but generally the dry matter content is between 25 – 50%. In addition to its nutritive qualities, it has also proven to be a highly palatable feedstuff, which can effectively be used to boost consumption of other feed ingredients. CDS is a brown, free flowing to semi-solid liquid similar in viscosity to molasses. Because of the fermentation of the sugars, it is less sweet than molasses, and the taste ranges from neutral too slightly sour. Because of its nutritive composition and high palatability, CDS can be a valuable addition to many livestock rations, especially those requiring high nutrient density or those diets which include ingredients which animals may find less acceptable such as

poorer quality roughages. Like other feedstuffs, it performs best as a component of a properly balanced ration.

- **Corn Distillers Dried Grains with Solubles** (DDGS) are recovered in the distillery and contain all the nutrients from the incoming corn less the starch. Thus the DDGS has at least three fold as much nutrients as the incoming grain. Approximately 4% of the amino acid in corn is broken down and then reconverted to the more nutritionally valuable microbial types. Since the stillage is recycled, the ratio of these more valuable amino acid types continues to increase so that eventually they represent approximately 16% of the final DDGS's amino acid content. No other feed ingredient (corn gluten feed or meal, soybean meal, etc) results from such a great percentage of microbial products and their back stocking. The yeast also provides increased vitamins, particularly the B-complex group. DDGS typically analyzes as 27% protein, 11% fat and 9% fiber. DDGS provides ruminants with an excellent source of bypass protein. This product is also available in a wet form. DDGS has been successfully included in rations for beef and dairy cattle, poultry, swine, aquaculture and pet foods.

The corn plant is an efficient factory for converting large amounts of radiant energy from the sun into a stable form of chemical energy stored as cellulose, oil and starch. It has proven to be a very versatile grain. The end products produced from corn are used in our everyday life. As we expand the processing of corn by investing in research that looks for more value added components or harvest the crop to produce expanded quantities of renewable liquid transportation fuels we will also generate more quantities of excellent co-products for the feed industry.

Acknowledgments: National Corn Growers Association and Corn Refiners Association

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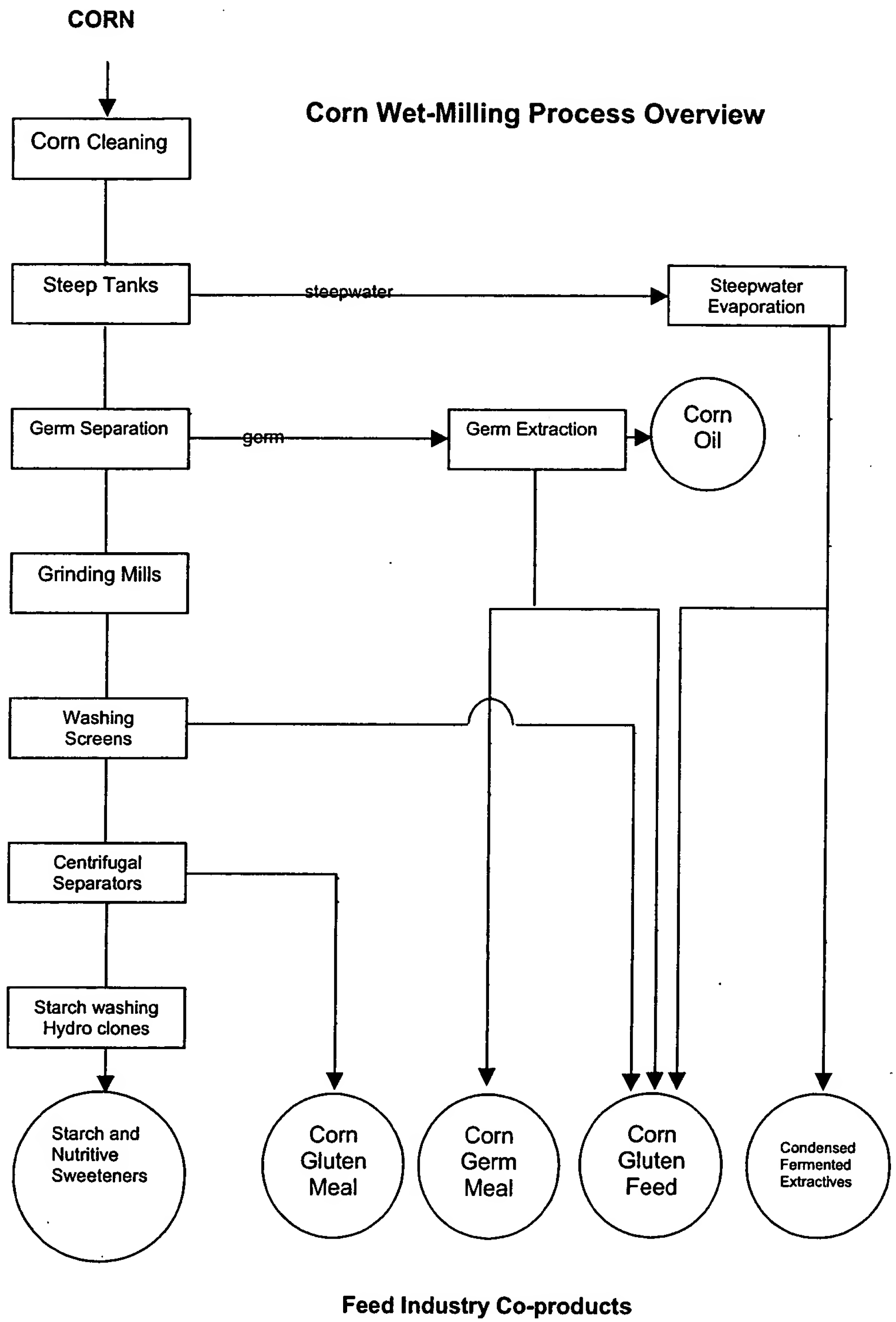
Kelly S. Davis
Quality Manager
Chippewa Valley Ethanol Company

Minnesota Nutrition Conference
Minnesota Corn Growers Association
Technical Symposium
September 11, 2001



Presented by
Kelly S. Davis
Quality Manager
Chippewa Valley Ethanol Company

Minnesota Nutrition Conference
Minnesota Corn Growers Association
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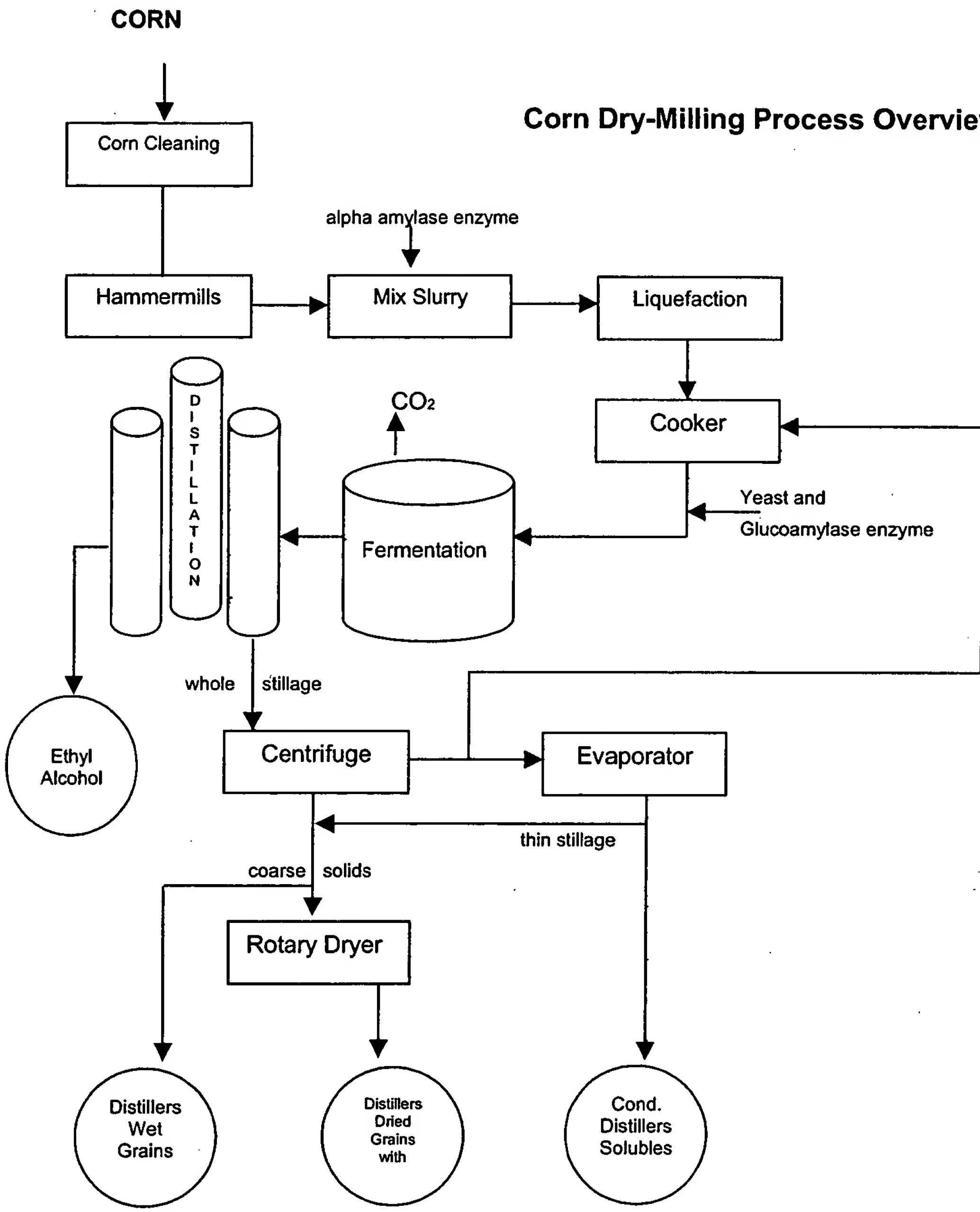
Corn Dry-Milling Process Overview



Feed Industry Co-products

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